BEWT

REPORT ON WATER QUALITY IN ROUND LAKE

1972

The Honourable
James A. C. Auld
minister

Everett Biggs
deputy minister

Ministry of the Environment
Ontario

REPORT

ON

WATER QUALITY

IN

ROUND LAKE

1972

GENERAL TABLE OF CONTENTS

LIST OF FIGURES ii

PREFACE iii

SUMMARY v

PURPOSE OF THE SURVEYS 1

DESIGN OF THE SURVEYS
- Timing 2
- Selection of Sample Locations 3
- Field Tests 3
- Bacteriological Tests 3
- Chemical Tests 5

DESCRIPTION OF ROUND LAKE AREA
- Lake and Soil Characteristics 8
- Shoreline Development 11
- Water Usage 11

RESULTS AND DISCUSSION
- Bacteriology 12
- Chemistry 17
- Chlorophyll a and Water Clarity 19
- Aquatic Plants 21
- Future Considerations 24

TABLE 1
- A List of Aquatic Plants Found in Round Lake 25

INFORMATION OF GENERAL INTEREST TO COTTAGERS
- Microbiology of Water A-1
- Rainfall and Bacteria A-2
- Water Treatment A-3
- Septic Tank Installations A-5
- Dye Testing of Septic Tank Systems A-5
- Boating Regulations A-6
- Ice Oriented Recreational Activities A-7
- Eutrophication or Excessive Fertilization and Lake Processes A-8
- Control of Aquatic Plants and Algae A-9
- Phosphorus and Detergents A-11
- Ontario's Phosphorus Removal Program A-12
- Control of Biting Insects A-13

LIST OF FIGURES

Figure 1	Use of Secchi Disc to Determine Water Clarity	4
Figure 2	Cottage Development and Contours of Round Lake	7
Figure 3	Soil Types Near Round Lake	9
Figure 4	Distribution of Bacteria In June	15
Figure 5	Distribution of Bacteria In August	16
Figure 6	Dissolved Oxygen and Temperature Profiles at Stations 38 and 39	18
Figure 7	The mean of Chlorophyll a and Secchi Disc Measurements in Round Lake Relative to a Curve describing the Chlorophyll a - Secchi Disc Relationship in Many Ontario Lakes	20
Figure 8	Major Areas of Shoreline Aquatic Plant Growth	22
Figure 9	Photographs of Some Common Aquatic Plants Found in Round Lake	23

PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

A heavy influx of people may subject a lake and the sorrounding environment to great stress. In many cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over harvesting or the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an ever greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970, in order to solve the cottage waste disposal problem in recreational lakes. There are

three on-going studies carried by the Ministry:

1) evaluation of existing waste disposal systems and enforcement of repairs to those found to be unsatisfactory.

2) research to improve the knowledge of septic tank operation and effects in shallow soil areas and evaluation of alternative methods of private waste disposal.

3) evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972, in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

This report on Round Lake is one of a series dealing with the water quality aspects of the recreational lakes studies in 1972. As well as defining the present status of water quality in the lakes, the data are meant to provide an historical reference for comparison of conditions at any future time.

SUMMARY

Surveys were carried out in Round Lake in 1972 in June, August, and September-October, to evaluate the present status of the water quality with respect to bacteria, algae and aquatic plant growth. Plant nutrient and dissolved oxygen concentrations in the surface and bottom waters were determined.

Round Lake is located in the County of Renfrew and is part of the Bonnechere River Watershed. Its saucer-like shape covers a surface area of 31 kilometers (12 square miles) bound by gently sloping shoreline. The shoreline soil cover around the lake, although sandy, was found to be generally quite shallow and thus much of it can be considered as unsuitable for installation of standard subsurface septic tank systems. At the present time there are approximately 190 cottages positioned around the lake in addition to two small hamlets consisting of about 70 permanent dwellings.

The bacteriological status of Round Lake during the surveys was generally good and well within the Ministry of Environment Criteria. The August survey displayed higher bacterial concentrations than the June survey. Since rainfall occurred only in trace amounts during both surveys, the increased bacterial activity in August was probably brought about by increased summer recreational use of the lake. The Sherwood River inlet (Station 33) indicated a potential health risk to bathers and this will be investigated further.

The lake water was relatively soft and did not appear to have any unusual mineral characteristics. Nutrient and suspended algae concentrations were

low. Temperatures and dissolved oxygen content in the lake were characteristic of small deep lakes and were sufficient to maintain cold water species of fish during all three surveys.

Aquatic plants of at least seven different species were identified but occupied only 10% of the shoreline.

PURPOSE OF THE SURVEYS

The surveys were disigned, and tests selected, in order to evaluate the present conditions in the lakes with respect to:

- concentration of bacteria
- plant nutrients and algae
- water quality with depth
- density and species of aquatic plants
- inventory of shoreline development

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment, microbial contamination and excessive growths of algae and aquatic plants. The two problems can result from a common or different source of pollution, but the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions, since most disease causing bacteria do not persist in the lake.

Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers (plant

nutrients), mainly nitrogen and phosphorus, support extensive growths of rooted aquatic plants and of microscopic free-floating plants called algae. Eutrophication greatly affects the lake appearance but generally does not pose a health hazard. Problems due to nutrient enrichment are generally long lasting and may become irreversible.

Changes in water temperature, dissolved oxygen and quality with depth are very important characteristics of a lake and were examined in the surveys.

The growth of weeds along the shore was noted during the surveys. Aquatic weed beds provide shelter and food for many kinds of fish. Too much growth is undesirable since it can upset the oxygen balance in the lake and can interfere with recreational uses of the lake.

DESIGN OF THE SURVEYS

Timing

Five day bacteriological, chemical and biological surveys were carried out from June 15 to 19 and from August 10 to 14. Chemical samples were collected over a three day period from September 30 to October 2.

A proper estimation of the bacterial population requires several measurements over a period of time which can then be averaged as a geometric mean. Measurements over 5 consecutive days at each station are regarded as the minimum number which will give reliable bacterial data.

Chemical samples were collected on the first and last days of the surveys at inlet and outlet stations and on the first, third and fifth days at the mid-lake stations. Chlorophyll samples were collected each day at the inlet and mid-lake stations.

Selection of Sample Locations

Forty bacteriological sample sites were established over the whole lake. Chemical samples were collected at 3 inlet stations, 1 outlet station and at 2 mid lake stations. In addition to these surface samples, chemical and bacteriological samples were taken from the bottom water at the mid lake stations. Aquatic plant samples were collected in areas representative of sparse, medium and dense growth.

Field Tests

The temperature and dissolved oxygen values were measured at the deep water stations with an electronic probe lowered into the lake and water clarity was measured with a Secchi disc, (Figure 1). The pH and conductivity of the samples were measured in the field.

Bacteriological Tests

Three groups of bacteria were determined on each sample: total coliforms, fecal coliforms, fecal streptococci. These organisms are used as "indicators" of fecal contamination. Many diseases common to man can be transmitted by feces, consequently, the probability of occurrence of these diseases is usually highest in areas where the water is contaminated. The total coliforms, fecal

The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.

Clear, algae-free lake: Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake: Secchi disc readings tend to be less than 3m (9 feet).

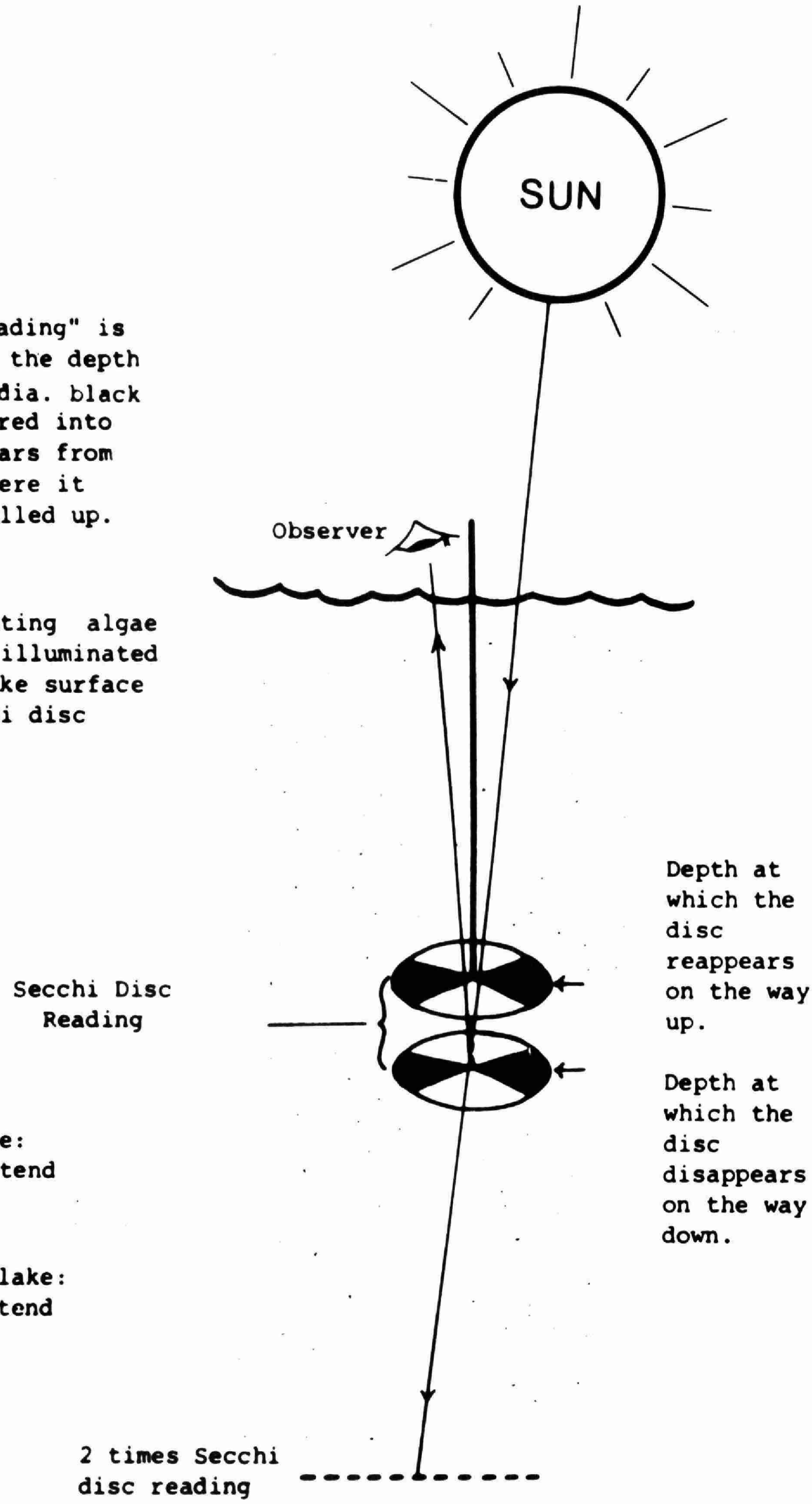


FIGURE 1: USE OF THE SECCHI DISC TO DETERMINE WATER CLARITY.

coliforms and fecal streptococci organisms are all indigenous to man and other warm blooded animals and are found in the colon and feces in tremendous numbers. Hence, these indicator organisms in the water denotes the presence of fecal contamination and hence the risk of disease causing organisms.

Standard plate count (SPC) determinations were made on some mid-lake stations in order to determine densities of some natural water bacteria. The SPC media will only support the growth of those organisms that don't require special nutrients, oxygen requirements and/or incubation temperature. The SPC is used as a measure of general bacterial activity.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured in order to define the mineral composition of the water. The types of plants and animals which thrive, effects of toxic materials and suitability of the lake for various management techniques depend on the mineral content.

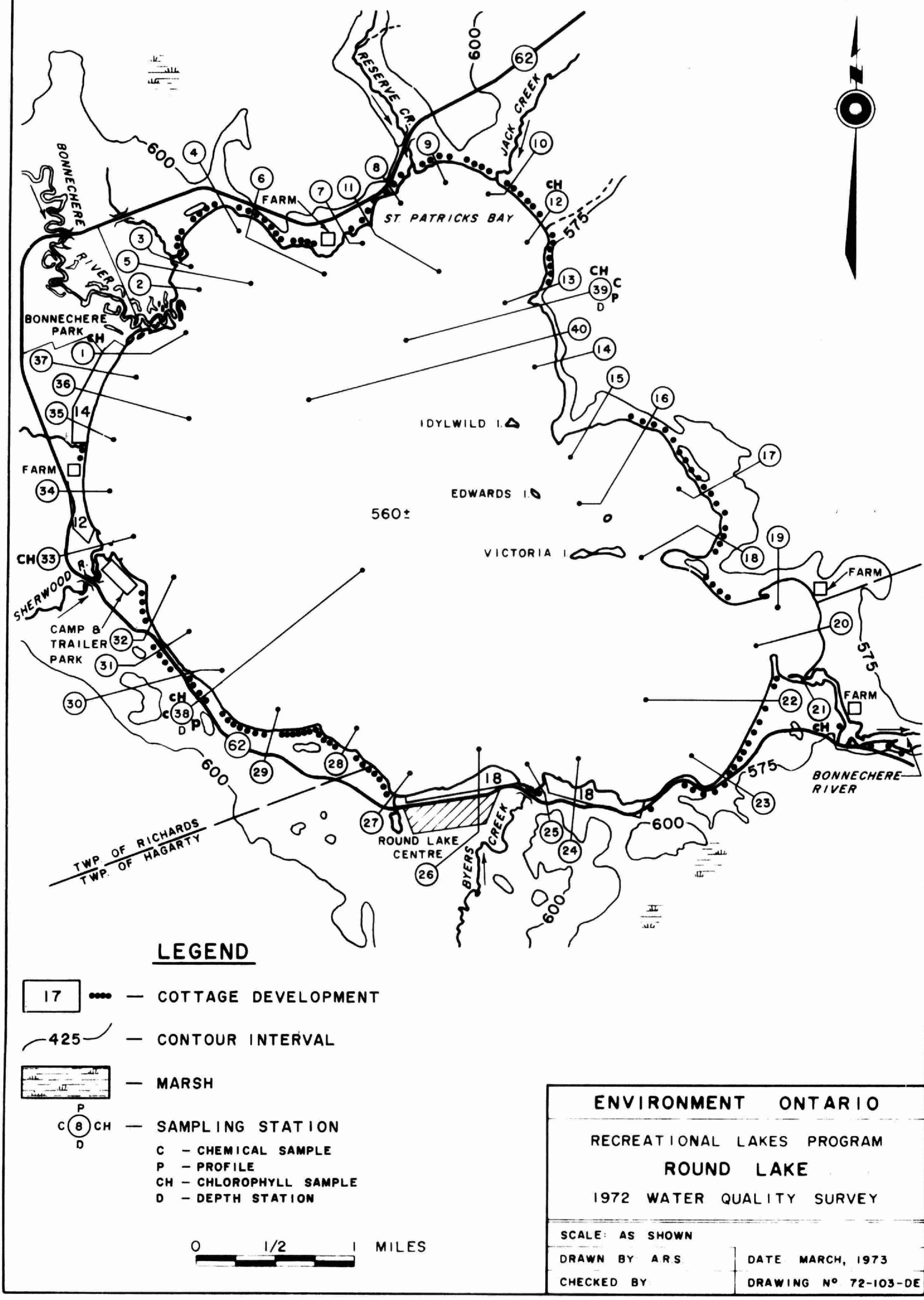
Total and soluble phosphorus were measured in the inlet and bottom water samples while total phosphorus only was measured in the mid-lake and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total Kjeldahl nitrogen is essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples. The soluble forms of nitrogen, ammonia, nitrite and nitrate were measured in the inlet and

bottom water samples. They are particularly important in bottom waters since nitrogen is regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of algae in the water. The live algae are confined mainly to the illuminated surface waters which extend down to a depth of about twice the Secchi disc reading. The chlorophyll samples were collected by raising the sample bottle through the depth of the illuminated zone as it filled. The sample was then representative of the average number of algae through the depth of the surface waters.

FIGURE 2 - COTTAGE DEVELOPMENT AND CONTOURS OF ROUND LAKE



DESCRIPTION OF ROUND LAKE AREA

Lake and Soil Characteristics

Round Lake is located in Richards and Hagerty townships, County of Renfrew and is approximately 40 kilometers (25 miles) south-west of Pembroke (Figure 2).

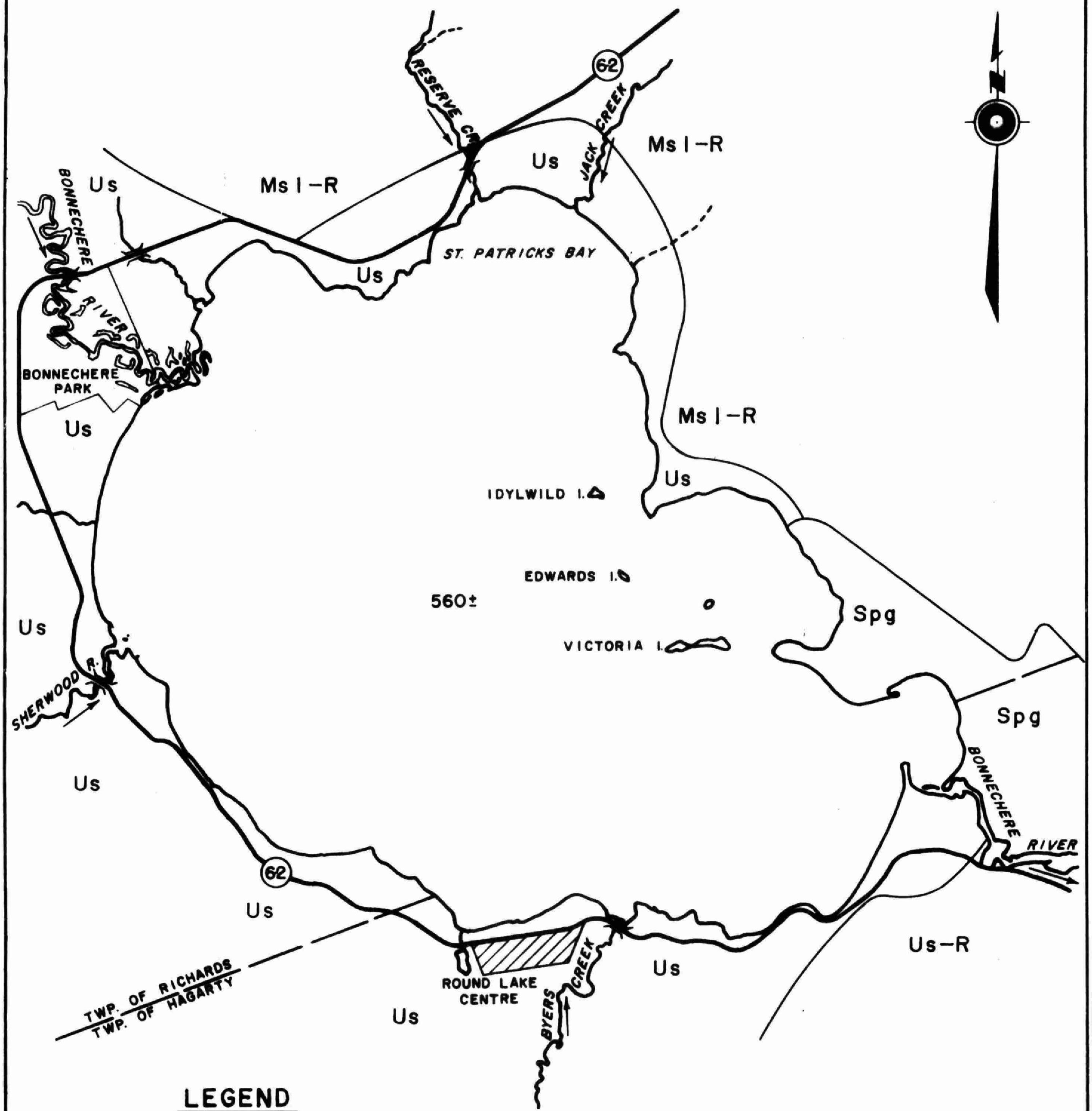
The lake lies entirely in the Canadian Shield and the area is characterized by good local drainage, crystalline bedrock, shallow overburden and rolling hills with the exception of the west shore which is relatively flat. The soil types surrounding the lake are comprised of a sandy loam to gravelly sand with some rock outcrop (Figure 3).

Round Lake has a diameter of approximately 8 kilometers (5 miles), a surface ares of 31 square kilometers (12 square miles) and a shoreline length of 31 kilometers (19 miles). The maximum depth of 54 meters (180 feet) is found in a small basin south of St. Patricks Bay (Figure 2). The mean depth is 13 meters (43 feet).

Round Lake has a drainage area of approximately 445 square kilometers (172 square miles), and is in the Bonnechere River watershed which empties into the Ottawa River. A number of lesser streams which flow into the lake are;

- the Sherwood River which drains Paugh, Surprise, Burnis, Little Round and Minkspay lakes,
- Turner Creek which drains Speckled, Sam and Ruddy lakes,
- Reserve Creek draining Rich and St. Patricks lakes,

FIGURE 3 - SOIL TYPES NEAR ROUND LAKE



LEGEND

Ms I-R	— MONTEAGLE SANDY LOAM ROCK
Spg	— ST. PETERS GRAVELLY SANDY LOAM
Us	— UPLANDS LOAM SANDY
Us-R	— UPLANDS LOAM SANDY ROCK

0 1/2 1 MILES

ENVIRONMENT ONTARIO	
RECREATIONAL LAKES PROGRAM ROUND LAKE 1972 WATER QUALITY SURVEY	
SCALE: AS SHOWN	
DRAWN BY: A.R.S.	DATE: MARCH, 1973
CHECKED BY:	DRAWING Nº: 72-103-DE

- Sacks Creek draining Lashes Lake.

The level of the lake is controlled by a dam on the Bonnechere River at its east end.

Shoreline Development

Cottage development on Round Lake is for the most part evenly distributed. There are approximately 190 cottages, all of which are accessible by road. The few lengths of shoreline which do not contain cottages have either steeply sloping shorelines or contain active farmland.

The Bonnechere Provincial Park which contains 115 campsites is located on the north-west shore. There are approximately 70 permanent dwellings in the area of the hamlets of Bonnechere and Round Lake Centre.

Water Usage

Most cottagers use the lake as their source of domestic water supply. Recreational use of the lake includes boating, swimming, and angling. The popular sport fish are yellow perch, largemouth and smallmouth bass and lake trout.

There are no direct discharges of wastes into Round Lake from communal or municipal sewage treatment facilities. There does not appear to be any pollution from the operation of existing municipal solid waste disposal sites.

RESULTS AND DISCUSSION

Bacteriology

The quantities of bacteriological data necessitated statistical methods to summarize the results into a concise presentation without the inconsistency associated with manual interpretation. The methods used are based on the analysis of variance and Barlett's test of homogeneity by which stations on a lake can be grouped into areas with the same bacterial level. Areas or stations with only slight differences in bacterial concentration can be isolated. It was found on previous work that areas, or stations, with significantly higher bacterial numbers generally indicated a pollution input. Details of statistical methods and data are available on request.

The data from the 1972 spring and summer surveys indicated that Round Lake was generally within the Ministry of the Environment (MOE 1973) Criteria which states: "Where ingestion is probable, recreational waters can be considered impaired when the coliform (TC), fecal coliform (FC), and/or enterococcus (FS) geometric mean density exceeds 1000, 100 and/or 20 per 100ml respectively.....". (1)

The June survey revealed that the majority of stations on the lake (Group A) had a mean total coliform (TC) geometric mean density of 33/100ml. The south-east portion of the lake (Group B) and the areas in the centre of the lake (Stations 38 and 39) exhibited considerably lower TC means than the remainder

of the lake.

The Bonnechere and Sherwood river inflows (Stations 1 and 33 respectively) had higher TC means of 415 and 338/100ml respectively. Most stations (Group A) had a fecal coliform (FC) mean of 1/100ml.

The Jack Creek inflow (Station 10) had a higher FC mean of 7/100 ml. Although the body of the lake was homogeneous with a FS mean of 6/100ml, the inlet stations (Stations 1,3,10 and 33) and the area between two moderately forested islands (Station 16) revealed higher FS means of 36, 28, 37, and 36/100ml respectively, considerably higher than the remainder of the lake. These higher FS levels at the inlets and the area between the forested islands might be attributed to natural sources.

The Killaloe Climatological Station recorded an average of 0.36 inches of rain during and prior to the June survey. Runoff from the land into the lake could have been induced by this rainfall, thereby accentuating the FS flora in the above mentioned regions.

In August, mean TC concentrations increased considerably over the June survey with most stations (Group A) having 181 TC/100ml.The east bay near the outflow to Bonnechere River (Group B) and the area just southwest of this bay near Hwy. 62 (Group C) had higher TC means of 811 and 783/100ml respectively, probably because of bacterial populations accumulating toward

the lake's outlet as a result of the very heavy rainfall on August 7, 8 and 9. The depth station (39D) revealed a TC mean of 17/100ml, while the station situated in the Sherwood River (Station 33) had a mean of 1512/100ml, exceeding the 1000 TC/100ml criteria.

FC densities were uniformly low throughout the lake at 2/100ml and no station exceeded the MOE Criteria for this parameter.

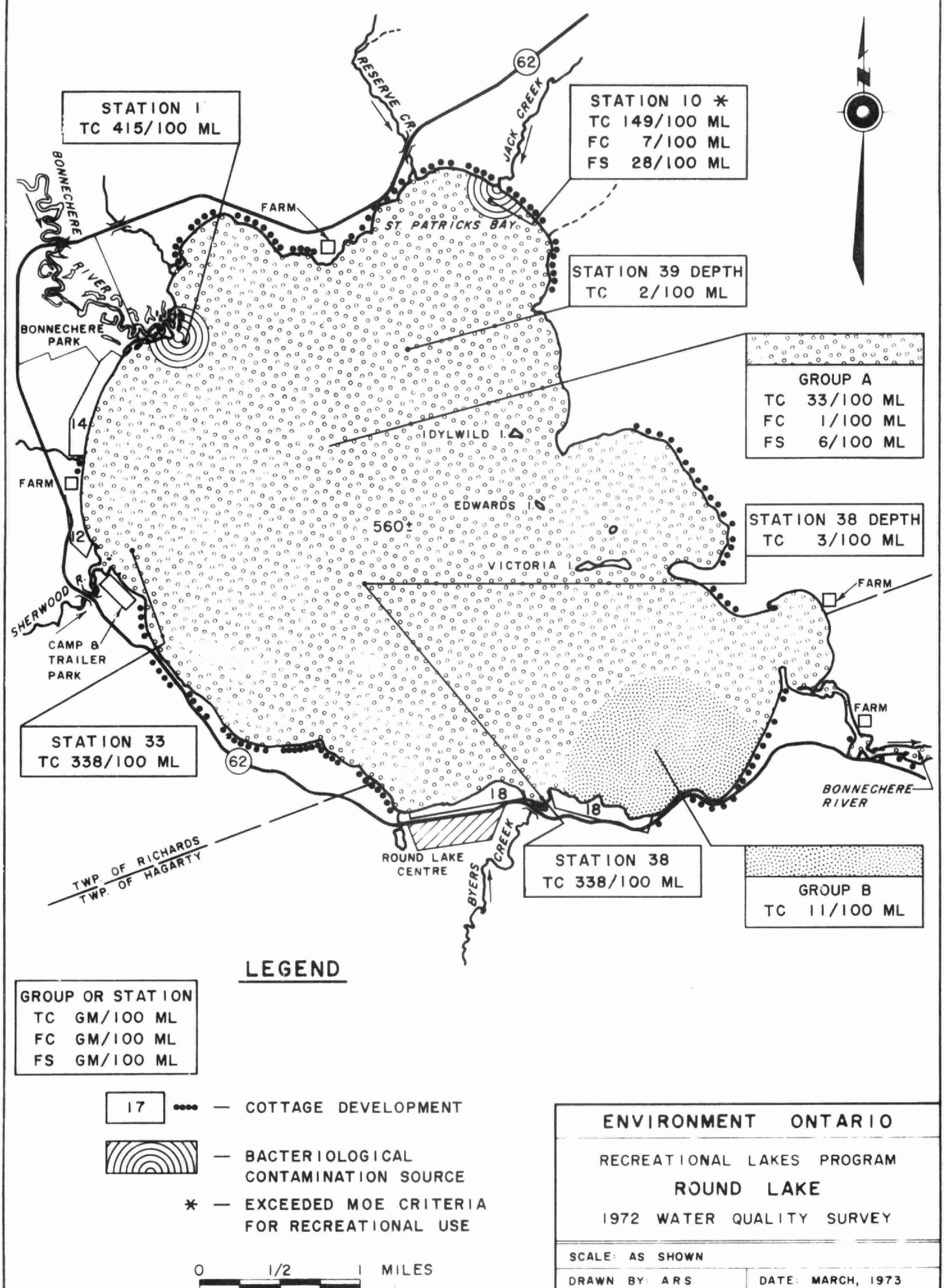
FS concentrations for the majority of stations (Group A) were very low with a mean of 1/100ml. The east bay of the lake (Group D) and the portion just southwest of this area with moderate cottage development (Group E), had densities of 31 and 29 FS/100ml respectively.

The Sherwood River (Station 33) had TC, FC and FS means of 1,512, 14 and 189/100ml respectively. Since the TC, FC and FS means were simultaneously high, the Sherwood River inflow was a bacterial pollution source and a potential health risk in the adjacent lake area is indicated.

Standard Plate Count (SPC) levels were carried out on stations in the centre of the lake (Stations 38, 39). In June SPC means were 1000 and 1600/100ml for these stations respectively, while the August survey revealed higher levels of 1400 and 3400 SPC/100ml.

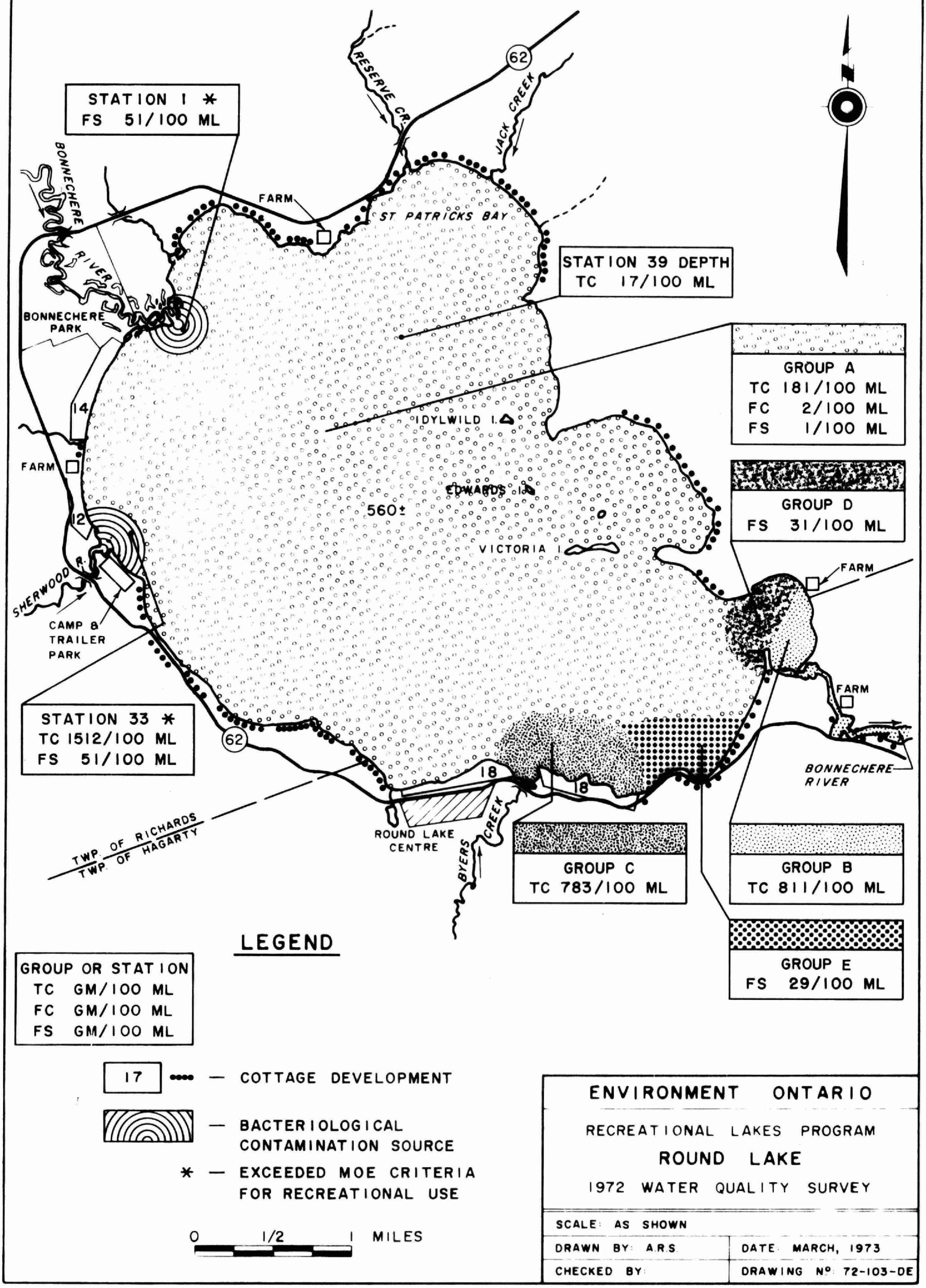
* A.
(1) Guidelines and Criteria for Water Quality Management in Ontario. MOE 1972.

FIGURE 4 - DISTRIBUTION OF BACTERIA IN JUNE



ENVIRONMENT ONTARIO	
RECREATIONAL LAKES PROGRAM ROUND LAKE 1972 WATER QUALITY SURVEY	
SCALE: AS SHOWN	
DRAWN BY: ARS	DATE: MARCH, 1973
CHECKED BY:	DRAWING Nº: 72-103-DE

FIGURE 5 - DISTRIBUTION OF BACTERIA IN AUGUST



Chemistry

During the June Survey, the Round Lake surface temperatures ranged from 15 to 17.5 C and the dissolved oxygen concentrations ranged from 85 to 125% saturation. At both mid-lake stations (38 and 39) temperatures through the water column had begun to stratify with a rapid decrease in temperature between 4 and 10 meters (Figure 6). By the August survey the zone of rapid temperature decline was much more prominent with a decline of 8.5 C between 7 and 12 meters at Station 38. Dissolved oxygen concentrations in the bottom waters during August ranged from 60 to 85% saturation. A slight oxygen decrease at about 12m was observed at both mid-lake stations during the August survey (Figure 6). This phenomenon is not uncommon and was probably brought about by chemical oxidation and bacterial decomposition of dead plant and animal matter suspended at these depths. During the September-October survey, the zone of rapidly declining temperatures was one meter thinner and was located four meters deeper than during the preceeding survey. The narrowing and downward shift of this zone is in keeping with the expected seasonal change and is characteristic of small deep lakes. Temperatures and dissolved oxygen content were sufficient to maintain cold water species of fish during all three surveys.

The hardness, alkalinity, chloride and conductivity ranges were consistent with each other at representative sampling stations indicating that no unusual mineral characteristics were present. These ranges were as follows:

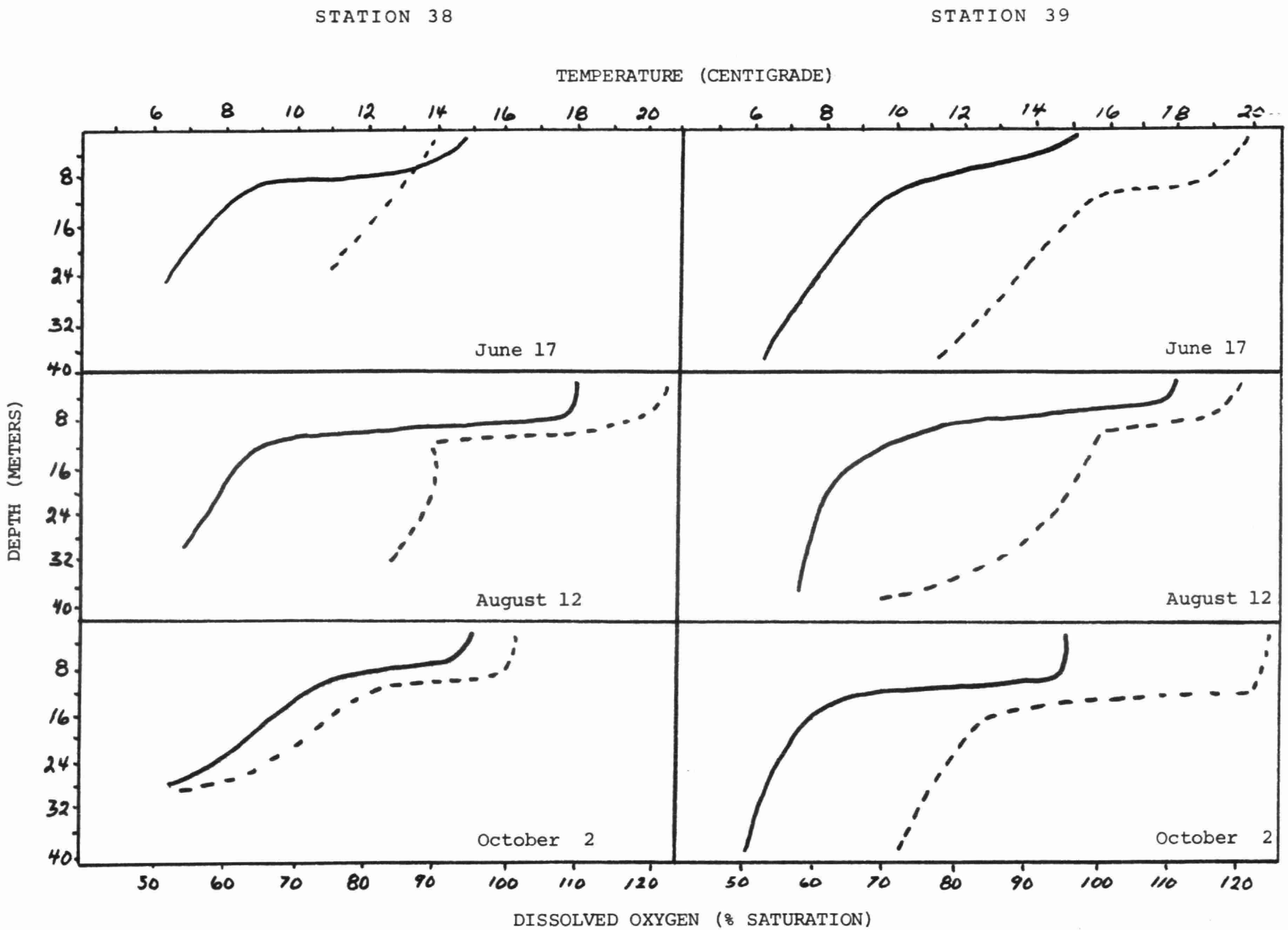


FIGURE 6: Dissolved oxygen (-----) and temperature (____) profiles at Stations 38 and 39 in Round Lake.

	Station 38	Station 39
Hardness	27-32 mg/1	27-33 mg/1
Alkalinity	17-22 mg CaCO /1	17-21 mg CaCO /1
Chloride	0.2-2 mg/1	0.1-3 mg/1
Conductivity	64-67 umhos/cm	61-67 umhos/cm

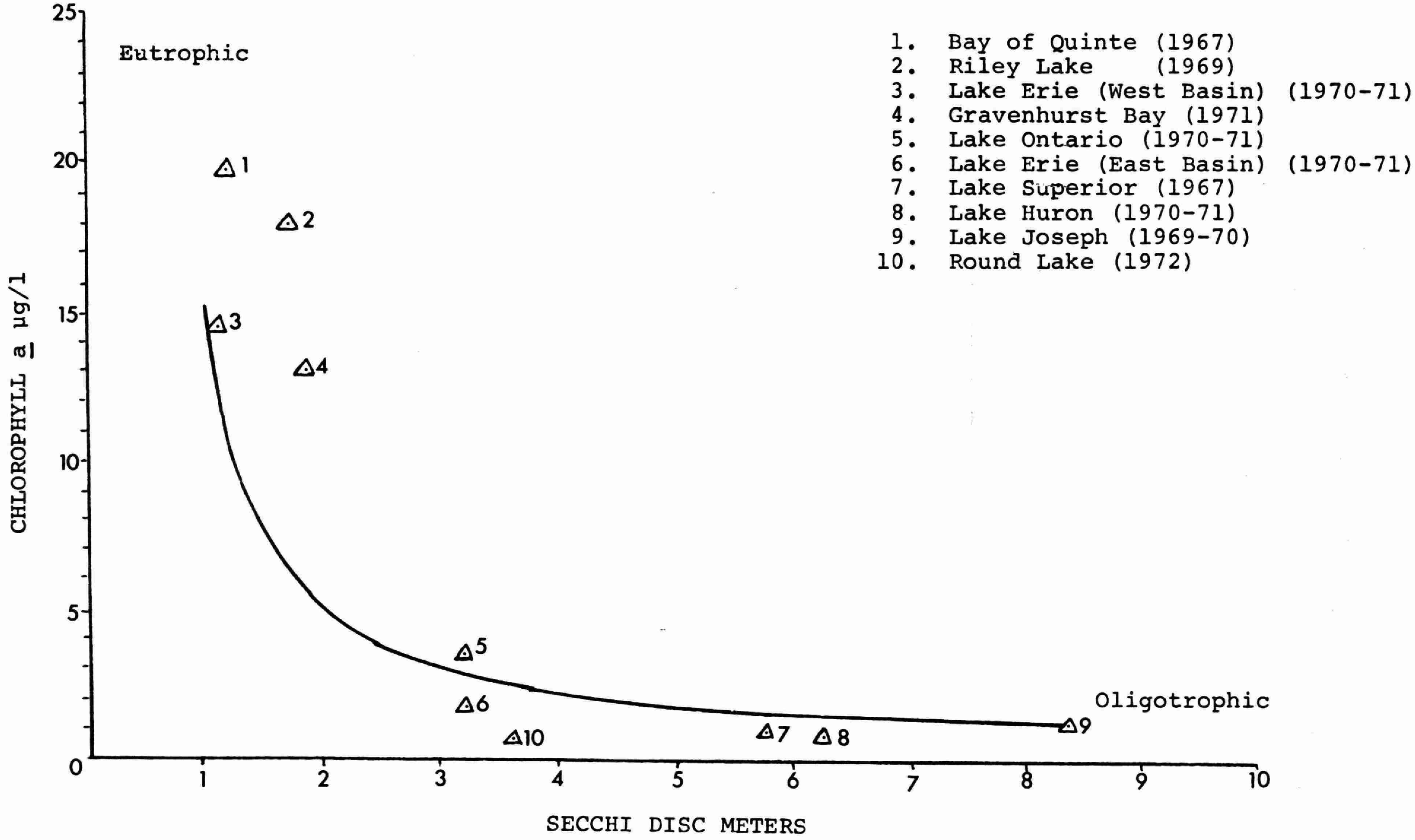
The lake water is relatively soft and the major inlet to the lake does not appear to have any unusual mineral content.

The surface concentrations of iron, total phosphorus and Kjeldahl nitrogen were low during all three surveys with mean mid-lake concentrations of 0.17mg Fe/1, 0.013mg P/1 and 0.35mg N/1 respectively. Bottom water concentrations were not significantly higher with no increases in these constituents occurring over the three surveys. The low nitrogen and phosphorus concentrations in the lake would not be expected to support nuisance amounts of algae and are not likely to increase naturally, since the major inlet was also characterized by low concentrations.

Chlorophyll a and Water Clarity

Mean concentrations of chlorophyll a during the spring, summer and fall surveys were 1.3, 0.6 and 1.0 respectively. These very low concentrations indicate the unenriched status of the lake. On a scale of lake enrichment as indicated by chlorophyll a concentrations and water transparency, Round Lake exhibits a low status of enrichment and is far removed from such highly enriched waters as the Bay of Quinte (Figure 7). Mean Secchi disc transparencies in Round Lake during the three surveys of 3.8, 4.0, 3.0 meters

Chlorophyll a - Secchi Disc Relationship

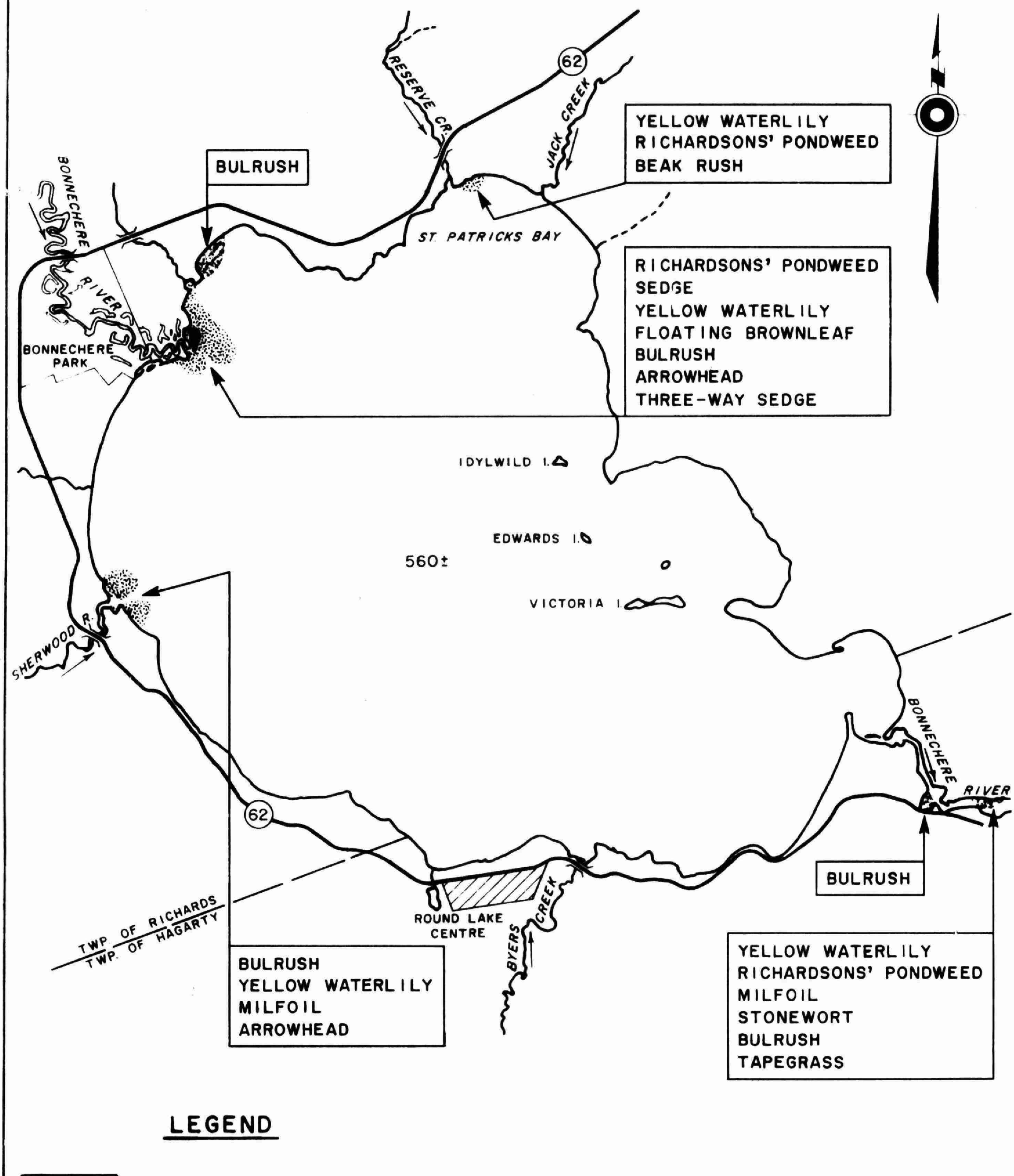


were somewhat less than those expected from turbidity due to suspended algae. Particulate or dissolved material other than living algae may have been important in reducing the transparency of the lake. Larger amounts of suspended algae in the lake are probably limited by lack of nutrients.

Aquatic Plants

Aquatic plant growth in shoreline areas of Round Lake was not extensive, with more than 90% of the shoreline free of major plant growth. In those areas where plant growth was prominent (Figure 8) ten genera and seven different species were identified (Table 1). Some of the plants could only be identified to genus because they lacked the fruiting or flowering structures necessary for complete identification. It is noteworthy that the major shoreline plant growths on the lake are found in or around the deltas of inflowing streams. Following heavy rainfalls, these streams likely carry a substantial sediment load which falls to the lake bottom at the mouth of the streams. Hence, a suitable substrate for aquatic plants in these shallow areas of Round Lake has built up over the years. Nutrient input from the streams probably helps to maintain the growths of aquatic plants in the delta areas. Some of the common species found in Round Lake are illustrated in Figure 9.

FIGURE 8 - MAJOR AREAS OF SHORELINE AQUATIC PLANT GROWTH



ENVIRONMENT ONTARIO

RECREATIONAL LAKES PROGRAM

ROUND LAKE

1972 WATER QUALITY SURVEY

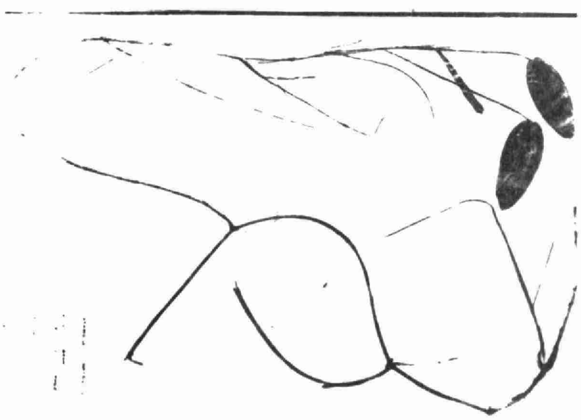
SCALE: AS SHOWN
DRAWN BY: A.R.S.
CHECKED BY
DATE: MARCH, 1973
DRAWING Nº 72-103-DE

RICHARDSON'S PONDWEED

BULLRUSH

ARROWHEAD

WILD CELERY



FLOATING-LEAF PONDWEED

STONEWORT

Figure 9: Photographs of some common aquatic plants found in Round Lake.

Future Considerations

A further investigation of the Sherwood River inlet will be undertaken in 1973 by staff of the Ministry of the Environment, to determine the source of contamination in the mouth of the Sherwood River.

Cottagers on the lake should ensure that their waste disposal systems are functioning properly , in order to prevent seepage of bacteria and nutrients to the lake.

Table 1 Aquatic plants found in shoreline areas of Round Lake and the number of areas in which each type occurred. For convenience, the plants are divided into two categories: (a) submergent - aquatic plants which live for the most part underwater and (b) emergent - plants which produce floating or aerial leaves.

Scientific Name (Genus, species)	Common Name	Distribution (number of areas)
(a) SUBMERGENT		
Chara sp*	Stonewort	1
Myriophyllum sp.	Milfoil	2
Potamogeton natans	Floating brownleaf; Floating-leaf pondweed	1
Potamogeton richardsonii	Richardsons' pondweed	3
Rynchospora cethalantha	Beak rush	1
(b) EMERGENT		
Carex sp	Sedge	1
Dulichium arundinaceum	Three-way Sedge	1
Nuphar sp.	Yellow waterlily	4
Safittaria sp.	Arrowhead	2
Scirpus sp.	Bulrush	3

* Chara is technically an alga, but because it grows in long strands, it is most often called an aquatic plant.

INFORMATION OF GENERAL INTEREST TO COTTAGERS
MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microorganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria do not change the appearance of the water but pose an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis but he may catch lesser infections of gastroenterities (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated with several water born viruses. These virus infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic matter in the lake will be used as food by these organisms and will be used as food

by these organisms and will give rise, in turn, to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attached by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amount of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

The standard plate count (SPC) populations given in the text supply an indication of the number of these bacteria in the lake.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomena that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area arrund the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling

B oil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination Using a Household Bleach Containing 4 to 5.1/4% Available Chlorine

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination

For continuous water disinfection, a small domestic hypochlorinator (sometime coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment

Well water can be disinfected using a household bleach (assuming

strength at 5% available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH
per 10 ft depth of water

Diameter of Well Casing In Inches	One to Ten Coliforms	More than Ten Coliforms
4	.5 oz	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires that you obtain permission in writing to install a septic tank system. Permission can be obtained from the local Medical Officer of Health or in some instances from the Regional Engineer of the Ministry of the Environment. Any other pertinent information such as sizes, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

-50 feet to any well, lake, stream or pond.
-5 feet to any building.
-10 feet to any property boundary

The tile field should not be closer than:

-100 feet to the nearest dug well.
-50 feet to a drilled well which has a casing to 25 feet below ground.
-25 feet to a building
-10 feet to a property boundary.
-50 feet to any lake, stream or pond.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct

connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING REGULATION

In order to help protect the lakes and rivers of Ontario from pollution it is required by law that sewage (including garbage) from all pleasure craft, including houseboats must be retained in equipment of a type approved by the Ministry of the Environment. Equipment which will be approved by the Ministry of the Environment includes (1) retention devices with or without circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

To be approved, equipment shall:

1. be non-portable,
2. be constructed of structurally sound material,
3. have adequate capacity for expected use
4. be properly installed,

5. in the case of storage devices, be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1.1/2 inch National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in regards to boating:

1. Motors should be in good mechanical condition and properly tuned.

2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.

3. Fuel hoses must be in good condition and all connections tight.

4. If the bilge is cleaned prior to the boating season, the waste material must not be dumped into the water.

5. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.

6. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".

7. Empty oil cans must be deposited in a leak-proof receptacle.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing regulations to control pollution from ice-oriented recreational activities. In past years, there has been indiscrimate dumping of garbage and sewage on the ice. The bottoms of fish huts have been left on the ice and become a navigational hazard to boaters in the spring. Broken glass has been left on the ice only to become

injurious to swimmers. With the anticipated introduction of the regulations, many of these abuses will become illegal.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

The changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

Aquatic plants and algae are important in maintaining a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool which is essential to certain species of fish and also provide protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years in which extra nutrients are added to the lake and a return to the natural state may also take a number of years after the nutrient inputs are stopped. Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters

warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition can aggravate the condition and in some cases can result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with

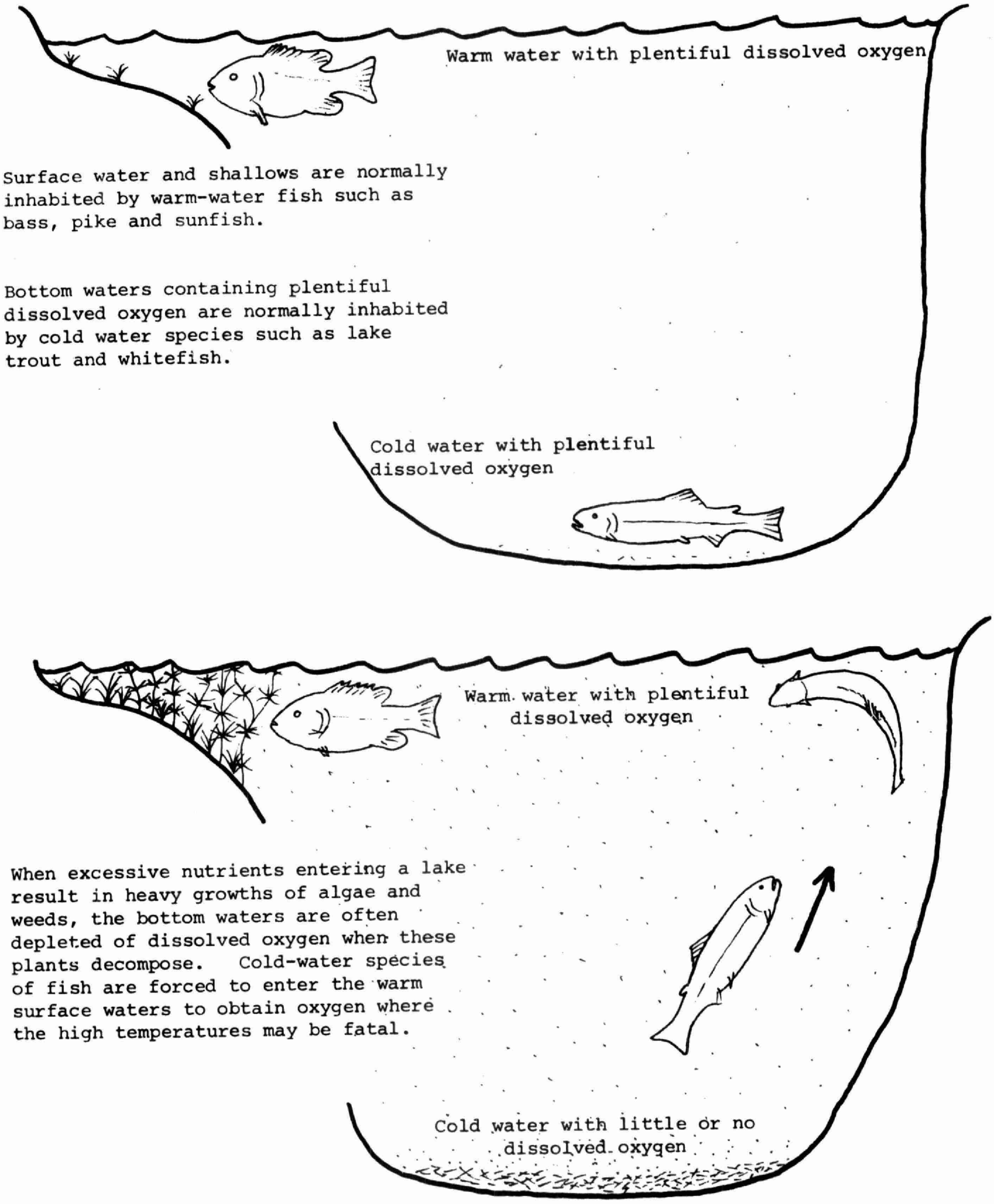


FIGURE A-1: DECOMPOSITION OF PLANT MATTER AT THE LAKE BOTTOM CAN LEAD TO DEATH OF DEEP-WATER FISH SPECIES.

boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Biology Section, Water Quality Branch, Ministry of the Environment, Box 213, Rexdale, Ontario.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced

the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the recently approved government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAM

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The program is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The program makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities must be operational at wastewater treatment plants by December 31, 1973, in the most critically affected areas

of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975. The 1973 phase of the program will involve 156 plants of which 85 are in the Lake Erie basin and another 30 in the Lake Huron drainage basin. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons. The 1975 phase will bring into operation another 57 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligrams per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extemely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved

larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Biology Section, Water Quality Branch of the Ministry of the Environment, Box 213, Rexdale, Ontario.